



## **ENVIRONMENTAL PROTECTION AGENCY**

**6560-50-P**

**[EPA-HQ-OAR-2014-0609; FRL-9965-08-OAR]**

### **Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's**

#### **Compliance with the Disposal Regulations; Recertification Decision**

**AGENCY:** Environmental Protection Agency (EPA).

**ACTION:** Notice; recertification decision.

**SUMMARY:** With this notice, the Environmental Protection Agency (EPA or the Agency) recertifies that the U.S. Department of Energy's (DOE) Waste Isolation Pilot Plant (WIPP) continues to comply with the "Environmental Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic (TRU) Radioactive Waste."

This action represents the Agency's third periodic evaluation of the WIPP's continued compliance with the disposal regulations and WIPP Compliance Criteria. The WIPP Compliance Criteria implement and interpret the disposal regulations specifically for the WIPP. As directed by Congress in the WIPP Land Withdrawal Act (WIPP LWA), this "recertification" process is required every five years following the WIPP's initial receipt of TRU waste on March 26, 1999 (e.g., March 2004, March 2009), until the end of the decommissioning phase. For each recertification—including the one being announced with this action—the DOE must submit documentation of the site's continuing compliance with the disposal regulations to the EPA for review.

This recertification decision is based on a thorough review of information submitted by the DOE, independent technical analyses, and public comments. The Agency has determined that the DOE continues to meet all applicable requirements of the WIPP Compliance Criteria, and with this action, recertifies the WIPP facility. This recertification decision does not otherwise

amend or affect the EPA's radioactive waste disposal regulations or the WIPP Compliance Criteria. In addition, recertification is not subject to rulemaking or judicial review, nor is it linked to the resumption of disposal activities at the WIPP facility. The EPA has also identified areas in which the DOE's technical analyses and justifications could be improved for the next recertification application.

**FOR FURTHER INFORMATION CONTACT:**

Ray Lee, Radiation Protection Division, Mail Code 6608T, U.S. Environmental Protection Agency, 1200 Pennsylvania Avenue, Washington, DC, 20460; telephone number: (202) 343-9463; fax number: (202) 343-2305; e-mail address: lee.raymond@epa.gov. Copies of the Compliance Application Review Documents (CARDS) supporting this action and all other recertification-related documentation can be found in the Agency's electronic docket found at [www.regulations.gov](http://www.regulations.gov) (Docket ID No. EPA-HQ-OAR-2014-0609).

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## Abbreviations

CARD	Compliance Application Review Document
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FR	Federal Register
NMED	New Mexico Environment Department
OAR	Office of Air and Radiation
Pa	Pascal
PBRINE	Parameter: Probability Distribution of Encountering Brine
RCRA	Resource Conservation and Recovery Act
SEN	Sensitivity Study
TRU	Transuranic
TSD	Technical Support Document
WIPP	Waste Isolation Pilot Plant
WIPP LWA	WIPP Land Withdrawal Act

## I. General Information

### A. *How Can I Get Copies of This Document and Other Related Information?*

1. *Docket.* The EPA has established a docket for this action under Docket ID No.

**EPA-HQ-OAR-2014-0609.** Publicly available docket materials are available either

electronically at <<http://www.regulations.gov>> or in hard copy at the Air and Radiation Docket

in the EPA Docket Center, (EPA/DC) EPA West, Room B102, 1301 Constitution Ave., NW, Washington, DC. The EPA Docket Center Public Reading Room is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number for the Public Reading Room is (202) 566-1744, and the telephone number for the Air and Radiation Docket is (202) 566-1742. As provided in the EPA's regulations at 40 CFR part 2, and in accordance with normal EPA docket procedures, if copies of any docket materials are requested, a reasonable fee may be charged for photocopying.

2. *Electronic Access.* You may access this Federal Register document electronically through the U.S. Government Publishing Office website at <https://www.gpo.gov/fdsys/browse/collection.action?collectionCode=FR>.

## **II. What is the WIPP?**

### **A. Background**

The Waste Isolation Pilot Plant (WIPP) is a disposal system for defense-related transuranic (TRU) radioactive waste. The WIPP Land Withdrawal Act (WIPP LWA) of 1992 defines TRU waste as materials containing alpha-emitting radioisotopes, with half-lives greater than twenty years, in concentrations greater than 100 nanocuries per gram (nCi/g), except for (A) high-level radioactive waste; (B) waste that the Secretary has determined, with the concurrence of the Administrator, does not need the degree of isolation required by the disposal regulations; or (C) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with part 61 of title 10, Code of Federal Regulations (CFR). Developed by the U.S. Department of Energy (DOE), the WIPP is located near Carlsbad in southeastern New Mexico. At the WIPP, the DOE disposes of radioactive waste 655 meters (2,150 feet)

underground in an ancient salt layer which will eventually creep and encapsulate the waste. The WIPP has a total capacity to dispose of 6.2 million cubic feet of waste.

Congress initially authorized the development and construction of the WIPP in 1980 “for the express purpose of providing a research and development facility to demonstrate the safe disposal of radioactive wastes resulting from the defense activities and programs of the United States.”<sup>1</sup> To further facilitate the development and operation of the WIPP, Congress passed the WIPP LWA in 1992 and amended it in 1996. The WIPP LWA only allows TRU radioactive waste generated by defense activities associated with nuclear weapons to be emplaced in the WIPP and explicitly prohibits high-level waste or spent nuclear fuel from being disposed of at the WIPP.

Most TRU waste proposed for disposal at the WIPP consists of items that have become contaminated as a result of activities associated with the production of nuclear weapons or with the clean-up of weapons production facilities, e.g., rags, equipment, tools, protective gear and organic or inorganic sludges. Some TRU waste contains hazardous chemicals used during weapons production, research and development and cleaning/maintenance/deactivation activities. Some of the waste proposed for disposal at the WIPP is known as legacy waste and has been stored for decades at various federal facilities across the United States, including major generator sites such as the Idaho National Laboratory, Los Alamos National Laboratory and Oak Ridge National Laboratory, and smaller generators such as Argonne National Laboratory and Lawrence Livermore National Laboratory. These facilities continue to generate small quantities of TRU

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<sup>1</sup> Department of Energy National Security and Military Applications of Nuclear Energy Authorization Act of 1980, Pub. L. 96-164, section 213.

waste. All TRU waste which the DOE plans to ship to the WIPP is subjected to the EPA's WIPP waste characterization requirements at 40 CFR 194.24.

The WIPP LWA provides the EPA the authority to oversee and regulate the WIPP. The WIPP LWA requires the EPA to conduct three main tasks, to be completed sequentially, to reach an initial compliance certification decision. First, the WIPP LWA requires the EPA to finalize general regulations for the disposal of highly-radioactive waste.<sup>2</sup> The EPA published these disposal regulations, located at subparts B and C of 40 CFR part 191, in the Federal Register in 1985 and 1993.<sup>3</sup>

Second, the WIPP LWA requires the EPA to develop criteria, via rulemaking, to interpret and implement the general radioactive waste disposal regulations specifically as they apply to the WIPP. In 1996, the Agency issued the WIPP Compliance Criteria (40 CFR part 194).<sup>4</sup>

Third, the WIPP LWA requires the EPA to review the information submitted by the DOE every five years to demonstrate continued compliance with the disposal regulations and determine whether or not the WIPP continues to be in compliance.<sup>5</sup> The Agency issued the initial certification decision on May 18, 1998 (63 FR 27354-27406).

#### ***B. Impacts of February 2014 Incidents on the Repository***

Since the EPA's initial certification, operation of the WIPP proceeded without substantial interruption until 2014. However, two events took place at the WIPP in February 2014 that led the DOE to suspend emplacement of additional waste in the facility for nearly three years. On February 5, a salt haul truck caught fire. Workers were evacuated, and the underground portion of the WIPP was shut down. On February 14, a second event occurred when a continuous air

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<sup>2</sup> WIPP LWA, section 8(b).

<sup>3</sup> 50 FR 38066-38089 (September 19, 1985) and 58 FR 66398-66416 (December 20, 1993).

<sup>4</sup> 61 FR 5224-5245 (February 9, 1996).

<sup>5</sup> WIPP LWA, section 8(d).

monitor alarmed during the night shift, signaling a detection of radiation. The continuous air monitor was measuring exhaust from waste panel 7, where waste emplacement had recently begun. Radiological contamination of the underground caused an indefinite suspension of waste handling activities.

After implementing numerous corrective actions, the DOE resumed limited waste emplacement on January 4, 2017, and also resumed limited shipments from waste generator sites. Resumption of waste emplacement at the WIPP is unrelated to the EPA's recertification decision, which is primarily concerned with compliance with the EPA's long-term disposal requirements. However, the DOE has acknowledged that recovery from the radiological release will result in design changes to the repository, which will need to be considered from that longer-term perspective. These changes include installation of a new ventilation shaft and modification of the waste panel layout to accommodate the premature closure of planned waste emplacement capacity in panel 9. The DOE is still reviewing options and has not provided any specific plans to the EPA. The EPA will review these changes as more information becomes available and they are incorporated into future recertification applications. The EPA recognizes that the current recertification decision is based on a repository design that is likely to change, but the current application contains the information necessary to reach a decision without knowing the details of the future changes. It is not unprecedented for the EPA to conduct a recertification review with the knowledge that the DOE will submit a request to change an aspect of the disposal system design.

The EPA expects that any issues associated with repository design changes will be appropriately addressed in responding to change requests from the DOE and in subsequent recertification applications. However, because these design changes are likely to be substantial,



the EPA believes it is necessary for the DOE to ensure that future compliance recertification applications are as robust and technically defensible as possible. To that end, the EPA discusses in Section VI.D specific aspects of future compliance recertification applications that the Agency believes would benefit from independent technical review, or otherwise from thorough consideration of more recent scientific information and understanding of chemical processes anticipated to take place within the repository. The EPA strongly believes that incorporating such reviews and information into future applications will increase public confidence in the DOE's compliance demonstrations and facilitate the Agency's review.

### **III. Compliance Certification History**

#### **A. *1998 Certification Decision***

The WIPP LWA, as amended, required the EPA to evaluate whether the WIPP complied with the EPA's standards for the disposal of radioactive waste. On May 18, 1998 (63 FR 27354-27406), the EPA determined that the WIPP met the standards for radioactive waste disposal. This decision allowed the DOE to begin placing radioactive waste in the WIPP, provided that all other applicable health and safety standards, and other legal requirements, were met. The WIPP received the first shipment of TRU waste on March 26, 1999. The complete record and basis for the EPA's 1998 certification decision can be found in Air Docket A-93-02.

Although the EPA determined that the DOE met all of the applicable requirements of the WIPP Compliance Criteria in the original certification decision, the EPA also found that it was necessary for the DOE to take additional steps to ensure that the measures actually implemented at the WIPP (and thus the circumstances expected to exist there) were consistent with the DOE's compliance certification application and with the basis for the EPA's compliance certification. As a result, the EPA included four explicit conditions in the WIPP certification of compliance

(see 40 CFR part 194, Appendix A; WIPP Recertification Background Document in Docket No. EPA-HQ-OAR-2014-0609). These conditions are discussed in Section V.C of this document.

#### ***B. 2006 Recertification Decision***

The first recertification process, which occurred in 2004-2006, included an EPA review of all changes made at the WIPP facility since the original 1998 certification decision. The Agency received the DOE's first compliance recertification application on March 26, 2004. The EPA issued the completeness determination<sup>6</sup> for the 2004 Compliance Recertification Application by letter to the DOE on September 29, 2005 (see 70 FR 61107-61111, October 20, 2005). On March 29, 2006, the EPA officially recertified the WIPP facility for the first time (71 FR 18010-18021, April 10, 2006).

#### ***C. 2010 Recertification Decision***

Following receipt of the DOE's second compliance recertification application on March 24, 2009, the EPA requested additional information from the DOE and the DOE responded with the requested supplemental information. All pertinent 2009 Compliance Recertification Application correspondence was placed in the docket (Docket ID No. OAR-2009-0330 on [www.regulations.gov](http://www.regulations.gov)) and linked to on the WIPP website (<https://www.epa.gov/radiation/certification-and-recertification-wipp#tab2>). On June 29, 2010, the EPA sent a letter to the DOE announcing that the DOE's recertification application was complete (75 FR 41421-41424, July 16, 2010). The EPA's second recertification of the WIPP compliance was published on November 18, 2010 (75 FR 70584).

### **IV. With which regulations must the WIPP comply?**

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<sup>6</sup> A "completeness determination" is an administrative step by the Agency to notify the DOE and the public that the Agency has enough information to conduct a final technical review of the DOE's application. It does not reflect any conclusion regarding the WIPP's continued compliance with the radioactive waste disposal regulations at 40 CFR part 191 and the compliance criteria at 40 CFR part 194. The completeness determination represents the start of the six-month period specified in the WIPP LWA for issuance of the recertification decision.

***A. Compliance with Radioactive Waste Disposal Regulations & the WIPP Compliance Criteria***

The WIPP must comply with the EPA's radioactive waste disposal regulations, located at subparts B and C of 40 CFR part 191. These regulations limit the amount of radioactive material which may escape from a disposal facility, and protect individuals and ground water resources from dangerous levels of radioactive contamination. In addition, the compliance recertification application and other information submitted by the DOE must meet the requirements of the WIPP Compliance Criteria at 40 CFR part 194. The WIPP Compliance Criteria implement and interpret the general disposal regulations specifically for the WIPP, and clarify the basis on which the EPA makes the certification decision.

***B. Compliance with Other Environmental Laws and Regulations***

In addition to the EPA's radioactive waste disposal regulations, the WIPP must also comply with a number of other federal laws and regulations pertaining to public health and safety or the environment, including, for example, the Solid Waste Disposal Act (also known as the Resource Conservation and Recovery Act (RCRA)) (42 USC §§ 6901 et seq.) and the EPA's environmental standards for the management and storage of radioactive waste (subpart A of 40 CFR part 191). Various regulatory agencies are responsible for overseeing the enforcement of these federal laws and regulations. For example, enforcement of some parts of the hazardous waste management regulations has been delegated to the State of New Mexico. The State is authorized by the EPA to carry out the State's RCRA programs in lieu of the equivalent federal programs, and New Mexico's Environment Department (NMED) reviews the DOE's permit applications for treatment, storage, and disposal facilities for hazardous waste, under Subtitle C of RCRA. NMED's RCRA authority, such as issuing a hazardous waste operating permit for the

WIPP, is not affected by the EPA's recertification decision. The DOE is responsible for biennially reporting to the EPA and the State of New Mexico on the WIPP's compliance with all applicable federal laws pertaining to public health and safety (WIPP LWA § 9).<sup>7</sup> This action does not address the WIPP's compliance with environmental or public health and safety laws and regulations other than the EPA's radioactive waste disposal regulations (40 CFR part 191) and the WIPP Compliance Criteria (40 CFR part 194).

## **V. Continuing Compliance with the WIPP Compliance Criteria**

The EPA monitors and ensures continuing compliance with the EPA regulations through a variety of activities, including the following: review and evaluation of the DOE's annual change reports, monitoring of the conditions of compliance, addressing planned change requests, inspections of the WIPP site and inspections of waste characterization operations. Because of the 2014 incident, the EPA also reviewed health and monitoring data to ensure the radiological releases remained below the limits of subpart A of 40 CFR part 191 and the Clean Air Act National Emissions Standards for Hazardous Air Pollutants at 40 CFR part 61, subpart H.

The DOE must timely report any planned or unplanned changes in activities or conditions pertaining to the disposal system that differ significantly from the most recent compliance application and, at least annually, report any other changes in disposal system conditions or activities (40 CFR 194.4(b)(3), (4)). The Department must also report any releases of radioactive material from the disposal system (40 CFR 194.4(b)(3)(iii)). In addition, the EPA may request additional information from the DOE at any time (§194.4(b)(2)). These requirements assist the EPA with monitoring the performance of the disposal system and evaluating whether the certification should be modified, suspended or revoked.

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<sup>7</sup> Compliance with these laws and regulations is addressed in the site's Biennial Environmental Compliance Report (BECR).

**A. *Annual Change Reports***

In addition to reporting significant changes to the WIPP disposal system, the DOE is required to report at least annually other changes to the conditions or activities concerning the WIPP disposal system (40 CFR 194.4(b)(4)). The DOE submitted the first annual change report in November 1998.

The DOE's annual change reports reflect the progress of quality assurance and waste characterization inspections, minor changes to the DOE documents, information on monitoring activities and any additional EPA approvals for changes in activities. All correspondence and approvals regarding the annual change reports can be found in hard copy in the Air Docket A-98-49, Categories II-B2 and II-B3.

**B. *Monitoring the Conditions of Compliance***

1. **Panel Closure Rulemaking.** Waste panel closure systems are required by the State of New Mexico during the WIPP's operational phase. Since they are a feature of the disposal system design, the EPA requires panel closures to be included in the long-term modeling of the repository. The panel closures impact long-term disposal system performance because they can impede brine and gas flow between waste panels. As originally promulgated, the WIPP Certification Condition 1 required the DOE to implement the Option D panel closure system at the WIPP, using Salado mass concrete.<sup>8</sup> By final action published October 8, 2014, the EPA modified Condition 1 to remove the specific reference to Option D and generally require that the DOE close filled waste panels as specifically approved by the EPA (40 CFR part 194, Appendix A, as amended; 79 FR 60750-60756). With the same action, the EPA approved a design which primarily consists of 100 feet of run-of-mine salt. The DOE submitted a

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<sup>8</sup> "Salado" mass concrete refers to concrete made using Salado brines instead of fresh water.

performance assessment<sup>9</sup> to support its request to change the panel closure system design. The DOE asserted that the performance assessment demonstrated that a panel closure design using run-of-mine salt would be compliant with the EPA's disposal regulations (40 CFR part 191). The modification to the WIPP Certification Condition 1 also removed the requirement for the Agency to make future panel closure design changes by formal rulemaking.

**2. Quality Assurance.** Certification Condition 2 requires each TRU generator site to establish and execute a quality assurance program for waste characterization activities. Section 194.22 establishes quality assurance requirements for the WIPP. The DOE must adhere to a quality assurance program that implements the requirements of ASME NQA-1-1989 edition, ASME NQA-2a-1990 addenda, part 2.7, to ASME NQA-2-1989 edition, and ASME NQA-3-1989 edition (excluding Section 2.1 (b) and (c), and Section 17.1). The EPA determined that the 2014 Compliance Recertification Application provides adequate information to verify the establishment and implementation of each of the applicable elements of the ASME NQA-1-1989. The EPA has also verified the continued proper implementation of the Nuclear Quality Assurance Program through periodic audits conducted in accordance with §194.22(e).

The EPA's determination of compliance with 40 CFR 194.22 can be found in Table 1 of the 2014 Compliance Recertification Application CARD 22. Between March 2008 and April 2012, the EPA conducted several quality assurance audits and found the site-specific quality assurance programs to be adequate. The EPA conducted quality assurance audits at several waste generator sites and entities supporting the WIPP Performance Assessment activities at Los

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<sup>9</sup> Performance assessment is an important tool used in various contexts or evaluations relating to the WIPP and such assessments are mentioned in different circumstances throughout this notice, especially in Section VI.E. In general, performance assessment means: "an analysis that: (1) identifies the processes and events that might affect the disposal system; (2) examines the effects of those processes and events on the performance of the disposal system; and (3) estimates the cumulative release of radionuclides, considering the associated uncertainties, caused by all significant processes and events" (40 CFR 191.12). Performance assessment, for example, is required to show compliance with containment requirements (40 CFR 191.13).

Alamos and Sandia Laboratories. The EPA also audited the quality assurance program of the Carlsbad Field Office.

**3. Waste Characterization.** Certification Condition 3 requires TRU waste generator sites to have waste characterization systems approved by the EPA. The Agency has conducted numerous audits and inspections at waste generator sites in order to implement Condition 3 and the relevant provisions of 40 CFR part 194, including §194.8. The EPA inspected site-specific TRU waste characterization programs implemented to (a) characterize physical and radiological components in individual waste containers and (b) demonstrate compliance with the WIPP waste disposal requirements at 40 CFR 194.24.

To support the 2014 Compliance Recertification Application, the DOE reported the EPA's waste characterization inspections and approvals between January 2007 and December 2012 (see Table 1 in CARD 8). The EPA evaluated previously approved site-specific waste characterization program for continued compliance in accordance with 40 CFR 194.24, as well as changes to the systems of controls approved as part of the baseline (initial) approvals, and concluded them to be technically adequate. The TRU waste sites approved by the EPA to ship contact-handled TRU waste to the WIPP facility in accordance with the requirements of §194.8 since the 2009 Compliance Recertification Application are as follows: Advanced Mixed Waste Treatment Project, Hanford's Richland Laboratory, Idaho National Laboratory, Los Alamos National Laboratory, Oak Ridge National Laboratory and Savannah River Site. Since the 2009 Compliance Recertification Application, the TRU waste sites approved by the EPA to ship remote-handled TRU waste to the WIPP facility in accordance with the requirements of §194.8 are Argonne National Laboratory, Bettis Atomic Power Laboratory, General Electric Vallecitos Nuclear Center, Idaho National Laboratory, Oak Ridge National Laboratory and Savannah River

Site. Since the 2009 Compliance Recertification Application, no waste characterization occurred at Bettis Atomic Power Laboratory, General Electric Vallecitos Nuclear Center, Hanford's Richland Laboratory and Oak Ridge National Laboratory.

During the period covered by the 2014 Compliance Recertification Application, all site-specific waste characterization systems of controls at active TRU waste generator sites had necessary baseline approvals. Over the years, when warranted, the EPA approved modification to waste characterization program components. Notices announcing the EPA inspections or audits are routinely published in the Federal Register and also announced on the Agency's WIPP website (<https://www.epa.gov/radiation/epas-role-waste-isolation-pilot-plant-wipp>) and WIPP-NEWS e-mail listserv.<sup>10</sup>

Records of the EPA's quality assurance correspondences and waste characterization approvals can be found in Air Docket A-98-49, Categories II-A1 and II-A4, respectively, as well as online in Docket ID No. EPA-HQ-OAR-2001-0012 on [www.regulations.gov](http://www.regulations.gov).

**4. Passive Institutional Controls.** Certification Condition 4 requires the DOE to submit a schedule and plan for implementing passive institutional controls, including markers and other measures indicating the presence of the repository. The standards under the WIPP Certification Condition 4 do not require the submission of any reports until the final compliance recertification application prior to closure of the WIPP. The EPA has not received any submissions from the DOE during the period addressed by the 2014 Compliance Recertification Application and has not taken any actions relating to Condition 4. The EPA anticipates that it will evaluate the DOE's compliance with Condition 4 of the certification when the DOE submits a revised schedule and additional documentation regarding the implementation of passive

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<sup>10</sup> For more information on the WIPP-NEWS e-mail listserv, see Section VIII.B below.



institutional controls. Once received, the information will be placed in the EPA's public dockets, and the Agency will evaluate the adequacy of the documentation. After receiving Condition 4 submissions from the DOE, and during the operational period when waste is being emplaced in the WIPP (and before the site has been sealed and decommissioned), the EPA will verify that specific actions identified by the DOE in the compliance certification application, and supplementary information (and in any additional documentation submitted in accordance with Condition 4) are being taken to test and implement passive institutional controls.

### ***C. Inspections***

The WIPP Compliance Criteria provide the EPA the authority to conduct inspections of activities at the WIPP and at off-site facilities which provide information relevant to compliance applications (40 CFR 194.21). The Agency has conducted periodic inspections to verify the adequacy of information relevant to certification applications. The EPA has conducted annual inspections at the WIPP site to review and ensure that the monitoring program meets the requirements of §194.42. The EPA has also inspected the emplacement and tracking of waste in the repository. The Agency's inspection reports can be found in Air Docket A-98-49, Categories II-A1 and II-A4, as well as online at [www.regulations.gov](http://www.regulations.gov), Docket ID No. EPA-HQ-OAR-2001-0012.

## **VI. What is the EPA's 2017 Recertification Decision?**

The EPA determines, in accordance with WIPP LWA § 8(f)(2), that the WIPP facility is in compliance with the final disposal regulations, subparts B and C of 40 CFR part 191. Compliance recertification ensures that accurate and up-to-date information is considered in the determination that WIPP remains in compliance with these radioactive waste disposal regulations. The EPA makes this recertification and determination of continued compliance

following the “Criteria for the Certification and Recertification of the WIPP’s Compliance with the 40 CFR part 191 Disposal Regulations” (WIPP Compliance Criteria, 40 CFR part 194), including the WIPP certification conditions (40 CFR part 194, Appendix A).

***A. Performance Assessment and the EPA’s Standards***

The disposal regulations at 40 CFR part 191 include requirements for containment of radionuclides. The containment requirements at 40 CFR 191.13 specify that releases of radionuclides to the accessible environment<sup>11</sup> must be unlikely to exceed specific limits for 10,000 years after disposal. The DOE assesses the likelihood that the WIPP will meet these release limits through a process known as performance assessment.

The disposal regulations provide that there must be a reasonable expectation that cumulative releases of radionuclides from the WIPP and into the environment over 10,000 years will not exceed specified quantities of these radionuclides (40 CFR 191.13 and Appendix A). A reasonable expectation standard is used because of the long time period involved and the nature of the events and processes at radioactive waste disposal facilities leads to uncertainties about future performance. The DOE’s probabilistic performance assessments assess the likelihood of environmental radionuclide release so that future uncertainties are accounted for in the calculations through the use of alternative scenarios and variations in values of uncertain parameters via probability distributions.

The containment requirements in 40 CFR 191.13 are expressed in terms of “normalized releases.” At the WIPP, the specific release limits are based on the estimated amount of waste in the repository at the time of closure, and the projected releases are “normalized” against these limits (§194.31). Normalized releases are expressed as “EPA units”. The EPA units are

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<sup>11</sup> The accessible environment is defined in 40 CFR 191.12 as (1) The atmosphere; (2) land surfaces; (3) surface waters; (4) oceans; and (5) all of the lithosphere that is beyond the controlled area.

calculated by dividing all the combined projected releases by the total combined radioactivity of all the waste in the repository.

The DOE must demonstrate, in each 5-year compliance recertification application, that the total average of combined releases are below two compliance criteria at a higher probability of occurrence and a lower probability of occurrence. These compliance points are as follows:

1. For a probability of 0.1 (a 1 in 10 chance) in 10,000 years, releases to the accessible environment will not exceed 1 EPA unit, and
2. For a probability of 0.001 (a 1 in 1,000 chance) in 10,000 years, releases to the accessible environment will not exceed 10 EPA units.

DOE evaluates four release mechanisms in the WIPP performance assessment modeling:

*Cuttings and cavings.* This consists of material that gets brought to the surface when a borehole intersects waste in a WIPP waste panel. The cuttings are the material intersected by the borehole itself and the cavings material is waste that fails around the borehole, collapses into it and is brought to the surface.

*Spallings.* This is solid material that fails and gets brought to the surface under high pressure conditions in the repository. This only occurs when the pressure is above 8 megapascal<sup>12</sup> (MPa).

*Direct Brine Releases.* This is a release of dissolved actinides in brine when there is sufficient brine and high pressure in the repository (i.e., above 8 MPa) and brine saturations are above residual saturation (i.e., brine is not “trapped” between pore spaces) as a borehole intersects a waste panel. The contaminated fluid is brought to the surface over a period of hours to days.

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<sup>12</sup> “Pascal” is a unit of pressure, defined as 1 kg/m-sec<sup>2</sup>.

*Releases to the Culebra.* This occurs when contaminated brine from repository is introduced via a borehole to the Culebra Dolomite and then moves to the edge of the accessible environment (i.e., the boundary established by the WIPP LWA).

The DOE estimates the potential releases from these release mechanisms, i.e., the cumulative releases, for comparison with the specified limits provided in 40 CFR part 191, Appendix A. The DOE is to provide in the application overall mean calculated releases and the upper 95<sup>th</sup> confidence limit of that mean.

***B. Summary of the EPA's Review***

After reviewing the DOE's documentation and additional studies that the DOE conducted at EPA's request, the aspects of the performance assessment of most interest to EPA are those that affect the direct brine release mechanism, by which actinides<sup>13</sup> dissolved in brine are transported to the surface during a drilling intrusion. Direct brine release is the overall dominant release mechanism at the low probability compliance point, and is influenced primarily by the availability of liquid (i.e., brine) in the repository, the availability of radionuclides to dissolve in that liquid (i.e., inventory and solubility) and the pressure in the repository (providing a motivating force for dissolved radionuclides to move out of the repository).

The key issues involving these aspects of the repository are: 1) the actinide solubility, which is addressed through changes to the geochemical database, colloid contribution updates and the determination of the actinide solubility uncertainty; 2) the probability of hitting a brine pocket under the repository; 3) the steel corrosion rate and steel's interactions with hydrogen sulfide and magnesium oxide (affecting the gas pressure); and 4) the overall modeling of direct

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<sup>13</sup> Actinide means any of the series of fifteen metallic elements from actinium (atomic number 89) to lawrencium (atomic number 103) in the periodic table. They are all radioactive, the heavier members being extremely unstable and not of natural occurrence.

brine releases that involve the interactions of items 1-3 plus the conditions of the repository (e.g., panel and drift permeability and porosity) that can influence the pressure characteristics of the waste areas. These issues are discussed in more detail in Section VI.D, along with other issues that are noteworthy but have more limited impact on performance assessment results.

The following information describes the EPA's compliance evaluation related to the disposal regulations and Compliance Criteria.

***C. What information did the Agency use to make the decision?***

In general, compliance applications must include information relevant to demonstrating compliance with each of the individual sections of 40 CFR part 194 to determine if the WIPP will comply with the Agency's radioactive waste disposal regulations at 40 CFR part 191, subparts B and C. The EPA begins the compliance recertification evaluation once the EPA receives a complete compliance recertification application (40 CFR 194.11).

To make this decision, the EPA evaluated basic information about the WIPP site and disposal system design, as well as information which addressed the various compliance criteria. As required by 40 CFR 194.15(a), the DOE's 2014 Compliance Recertification Application updated the previous submission in 2009.

On March 26, 2014, the DOE submitted the compliance recertification application. The EPA began to identify areas of the application where additional information was needed. On October 10, 2014, the EPA gave public notice of the compliance recertification application and opened the official public comment period (79 FR 61268). On January 13, 2017, the EPA sent a letter to the DOE stating that the DOE's recertification application was complete. On March 10, 2017, the EPA issued a Federal Register notice announcing the completeness determination and stating that the public comment period would close one month later, on April 10, 2017 (82 FR

13282). The compliance recertification application completeness-related correspondence can be found in Docket ID No. EPA-HQ-OAR-2014-0609 on [www.regulations.gov](http://www.regulations.gov).

The EPA relied on materials prepared by the Agency or submitted by the DOE in response to the EPA requests. For example, the EPA requested that the DOE conduct specific, additional modeling calculations for the performance assessment, known as sensitivity studies. The purpose of these studies was to evaluate the impact on performance assessment results of changing specific parameter values. The studies aided the EPA in determining how significant the differences in some parameter values were to a demonstration of compliance. The four sensitivity studies and the EPA's evaluation of them are discussed in more detail in Section VI.E.

To determine whether the WIPP facility continues to be in compliance with the final disposal regulations, the EPA engaged in a technical review of the compliance recertification application against the WIPP Compliance Criteria. The Agency focused the review on areas of change identified by the DOE since the 2010 recertification decision.

The Agency produced many documents during the technical review and evaluation of the compliance recertification application. The EPA's Compliance Application Review Documents (CARDS) correspond in number to the sections of 40 CFR part 194 to which the documents primarily relate. Each CARD enumerates all changes made by the DOE relating to a particular section of the rule or certification criterion, and describes the EPA's process and conclusions. The EPA also prepared technical support documents (TSDs) to address specific topics in greater detail. Both the CARDS and the TSDs for this recertification decision can be found in Docket ID No. EPA-HQ-OAR-2014-0609 on [www.regulations.gov](http://www.regulations.gov). Together, the CARDS and TSDs thoroughly document the EPA's review of the DOE's compliance recertification application and the technical rationale for the Agency's decisions.

In summary, the EPA's recertification decision is based on the entire record available to the Agency, which is located in the public docket dedicated to this recertification (Docket ID No. EPA-HQ-OAR-2014-0609 on [www.regulations.gov](http://www.regulations.gov)). The record consists of the 2014 Compliance Recertification Application, supplementary information submitted by the DOE in response to the EPA requests for additional information, technical reports generated by the EPA, the EPA audit and inspection reports, and comments submitted on the DOE's application and the EPA's completeness review during the public comment period. All pertinent 2014 Compliance Recertification Application correspondence was placed in the docket and linked to via the EPA's WIPP website (<https://www.epa.gov/radiation/certification-and-recertification-wipp>).

***D. Content of the Compliance Recertification Application (§§194.14 and 194.15)***

The DOE's WIPP compliance applications must include, at a minimum, basic information about the WIPP site and disposal system design, including information about the following topics: the geology, hydrology, hydrogeology and geochemistry of the WIPP disposal system and the WIPP vicinity; the WIPP materials of construction; standards applied to design and construction; background radiation in air, soil and water; and past and current climatological and meteorological conditions (40 CFR 194.14). Section 194.15 states that the DOE's recertification applications shall update this information to provide sufficient information for the EPA to determine whether or not the WIPP facility continues to be in compliance with the disposal regulations.

**1. Changes to the Disposal System Identified by the DOE.** In Section 15 of the 2014 Compliance Recertification Application, the DOE identified changes to the disposal system between the 2009 Compliance Recertification Application and 2014 Compliance Recertification Application and changes to technical information relevant to §§194.14 and 194.15. Noteworthy

changes identified by the DOE in the 2014 Compliance Recertification Application include the following: an update to the parameters defining drilling rate and plugging pattern, revisions to the calculations of the probability of encountering a pressurized brine reservoir, replacing the Option D panel closure design with run-of-mine salt, modeling open areas in the repository, revision of the steel corrosion rate, revision of the effective shear strength of waste, revisions of the repository water balance including variable brine volumes for radionuclides to dissolve and revisions of the colloid parameters.

Before determining that the compliance recertification application was complete, the EPA raised numerous technical questions with the DOE, as described below. For each topic, a brief summary is provided of how the DOE addressed the issue in the 2014 application, followed by the EPA's perspective on the change, including any follow-up analyses requested. The DOE also updated the waste inventory. This topic is discussed in Section VI.F.1.

Since the initial Compliance Certification performance assessment, the DOE's calculated releases in performance assessments have increased with every performance assessment until the 2014 Compliance Recertification Application performance assessment. The changes the DOE made to the performance assessment in the current application reduce the calculated releases. For example, the calculated release of radionuclides at the low probability compliance point (a likelihood of less than a one in 1,000 chance), was assessed by the DOE in the 2009 Compliance Recertification Application as 0.72 EPA Units, but in the 2014 Compliance Recertification Application, the similar calculated release initially was assessed as 0.261 EPA Units.

Changes that reduce the calculated releases involve the shear strength of the waste, revised steel corrosion rate, incorporating water balance as part of the chemical model implementation as it relates to steel corrosion and interactions with the magnesium oxide



engineered barrier, correcting errors associated with brine volume mass balance and calculation of actinide solubility and the change to how the DOE calculates the probability of hitting a brine pocket under the repository. In general, the result of the DOE's methodology changes is to reduce calculated releases by about a factor of two between the 2009 and 2014 Compliance Recertification Applications at both the 0.1 and 0.001 probability compliance points.

The EPA has identified issues with some of these changes, but even with changes the EPA asked the DOE to investigate, projected releases stay well under the numerical release limits. For example, at the 0.001 probability compliance point where the EPA normalized release limit is 10 EPA units, the changes the EPA requested resulted in increased releases from 0.261 EPA units in the DOE's 2014 performance assessment to 0.299 EPA units in sensitivity study SEN3 and 0.541 EPA units in sensitivity study SEN4. The sensitivity studies are discussed in depth in Section VI.E.

**a. Update to the Drilling Rate and Borehole Plugging Patterns.** As with previous recertification applications, the DOE updated the Delaware basin drilling rates based on the methodology previously approved. For the 2014 Compliance Recertification Application, the drilling rate increased to 0.00673 boreholes per km<sup>2</sup> per year (equivalent to 67.3 boreholes/km<sup>2</sup> over the 10,000-year regulatory period) compared to that used in the 2009 performance assessment baseline calculation, which was .00598 boreholes per km<sup>2</sup> per year (or 59.8 boreholes/km<sup>2</sup> over 10,000 years). The Agency accepted the DOE's drilling rate increase.

The DOE also updated information on the type of plugs installed in exploratory, disposal and resource extraction boreholes. There are three types of borehole plugs used in the Delaware basin. There are boreholes that are continuously plugged through the entire salt section, and the DOE reports a slight increase in the use of this design. There are boreholes plugged with a two-

plug configuration (at the Salado/Rustler and the Bell Canyon/Castile Formation interfaces). This two-plug design also slightly increased from that used in the 2009 application. There is also a three-plug configuration (i.e., borehole plugs at the Rustler/Salado, Salado/Castile and Castile/Bell Canyon interfaces); the DOE reports a slight decrease in this configuration. The Agency accepted the DOE's update to the change in the plugging patterns.

**b. Replacement of Option D Panel Closure System with the Run-of-Mine Salt Panel Closure Design.** Part of the design for the WIPP includes the use of a closure system to separate the waste rooms in a panel from active areas in the mine, which can affect long-term brine and gas flows within the repository. As part of the design, the panel closure system that is installed needs to be represented in the modeling of long-term performance.

On September 28, 2011, the DOE provided a change request to the EPA (Docket EPA-HQ-OAR-2013-0684) to modify the panel closure system design specified in Appendix A of 40 CFR part 194 from that of a concrete monolith plug, noted as Option D, to a 100-foot long barrier consisting of run-of-mine salt (EPA 2013; 2014). The panel closure system performance assessment release calculations were well within the numerical limits established in 40 CFR 191.13. The EPA approved the DOE's use of the proposed run-of-mine salt closure design (79 FR 60750, Oct. 8, 2014) (Docket EPA-HQ-OAR-2013-0684-0004 on [www.regulations.gov](http://www.regulations.gov)).

The DOE incorporated the run-of-mine salt design for panel closures into the 2014 Compliance Recertification Application. To evaluate this change, the Agency reviewed a broad set of information related to the evolution of salt repository properties, including run-of-mine salt and adjacent disturbed rock zone in the WIPP repository setting (Salt Characteristics TSD<sup>14</sup>). From this review, the Agency's interpretation of the data is that healing of the run-of-mine salt in

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<sup>14</sup> "Technical Support Document for Section 194.23: Technical Review of Salt Aggregate, Disturbed Rock Zone, and Open Drift Healing Characteristics" in Docket ID No. EPA-HQ-OAR-2014-0609.

the panel closures, the surrounding disturbed rock zone and open areas should occur within about the first 200 years of post-closure instead of the relatively asymptotic closure for the 200-10,000 years used by the DOE. The DOE's use of the longer period of time assumes permeability and porosity for the salt will be low within 200 years, but not at the very low end state properties of intact halite.

To identify the potential effect of the difference in the repository properties between what the EPA has identified may be applicable and what the DOE modeled, the Agency requested that the DOE analyze the repository performance using parameter values for the run-of-mine salt panel closure system and adjacent disturbed rock zone that simulate complete healing. The DOE did this in the sensitivity study SEN3 discussed in Section VI.E. The calculated releases increased for direct brine releases and spillings releases in SEN3, but overall releases remained well within the numerical limits of 40 CFR 191.13 and the EPA concludes that there is a reasonable expectation that the repository remains in compliance with the numerical limits at 40 CFR 191.13, and 40 CFR part 191, Appendix A.

If the DOE determines, in light of the announced decision to abandon the area previously designated for panel 9, that worker safety considerations preclude installing panel closures in affected areas of the repository, the DOE's treatment of panel closures in performance assessment may be more appropriately addressed in the context of modeling open areas representative of no panel closures. The Agency will review future panel closure modeling in the context of future facility design changes.

**c. Modeling of Open Areas in the Repository.** In the 2014 Compliance Recertification Application, the DOE increased the modeled volume of the open rooms and drifts by approximately forty percent to accommodate future planned experiments. These new areas

are located north of the waste area drifts and are to be separated from the waste area by two sets of run-of-mine salt panel closures. For the 2014 Compliance Recertification Application performance assessment, the DOE modeled these areas as open for the entire 10,000-year regulatory period even though it is expected that the creep closure process will close the open areas within a few hundred years (Overview TSD<sup>15</sup>). The Agency evaluated the impact of the DOE's assumption to model these areas as open (relatively large porosity and high permeability) by requesting the DOE perform sensitivity study SEN2, where the non-waste rooms and open drifts are assumed to have creep closed during the entire 10,000-year regulatory period.

The results from the SEN2 studies indicate modeling creep closure and healing of the operations and experimental areas (i.e., non-waste areas) of the repository was shown to have little effect on the prediction of total releases from the repository although, relative to the 2014 Compliance Recertification Application performance assessment, a slight increase in spillings releases does occur if these areas are assumed to creep closed. This is a result of higher pressures occurring in panels. See Section VI.E for discussion of the SEN2 study.

If, in the future, there are repository design changes that result in more non-waste drifts mined or left open in the facility, the issue of open areas will need to be re-evaluated in the context of those design changes, as releases could be expected to increase in that circumstance. The DOE's plan to abandon panel 9 would leave large areas of open space in the repository in the panel 9 drifts and possibly no panel closures for multiple panels. Performance assessment modeling should address these expected future repository conditions. The EPA believes that an independent technical review of issues related to salt behavior and modeling of open areas would be of benefit to the DOE as it further develops its plans.

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<sup>15</sup> "Overview of Changes Between PABC-2009 and CRA-2014 WIPP Performance Assessments" in Docket ID No. EPA-HQ-OAR-2014-0609.

**d. The DOE's Revised Estimate of the Probability of Encountering Pressurized Brine.** Highly pressurized zones of brine (i.e., pressurized brine reservoirs) occur in the Castile Formation below the Salado Formation, which is the formation that hosts the WIPP. If a future driller encounters a Castile pressurized brine reservoir and brine enters the waste panels, it can dissolve radionuclides that then could be transported up a borehole to the surface. In the modeling of the repository, the probability of a future borehole intersecting a waste panel and a Castile brine reservoir below the repository is denoted by the parameter name PBRINE. Because the probability of hitting a brine pocket is uncertain, it is represented by a probability distribution, and the actual value of the PBRINE parameter for an individual model run is sampled from the PBRINE probability distribution.

In the 2014 Compliance Recertification Application, the DOE changed the basis it used to develop the probability distribution for parameter PBRINE. The DOE's revision to the estimated probability of a future driller encountering pressurized brine relies heavily on voluntarily reported drilling logs<sup>16</sup> combined with an updated probability distribution. The DOE eliminated from consideration site-specific data collected through geophysical detection methods, which had previously been incorporated into the PBRINE parameter.

The EPA has several concerns regarding the DOE's update to the PBRINE parameter,<sup>17</sup> including the DOE's elimination of the site geophysical data leading to estimates of the potential for brine encounters based only on the voluntary data reported by the driller, and that more recent site data supports the potential for more brine under the repository than the DOE or the

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<sup>16</sup> Kirchner, T., T. Zeitler, and R. Kirkes. 2012. Evaluating the Data in Order to Derive a Value for GLOBAL:PBRINE. Memorandum to Sean Dunagan dated December 11, 2012. ERMS 558724. Carlsbad, NM: Sandia National Laboratories.; EPA Completeness Comment 1-23-6; Docket EPA-HQ-OAR-2014-0609-0004.

<sup>17</sup> See Completeness Question 1-23-6, Probability of Encountering a Castile Brine Pocket and subsequent clarifying questions, as well as the PBRINE TSD, for more detail in Docket ID No. EPA-HQ-OAR-2014-0609.

EPA had previously considered. For a more in-depth discussion of these issues, see the PBRINE TSD.<sup>18</sup> The EPA's concerns were significant enough that the EPA developed a modified methodology for determining the probability distribution for parameter PBRINE in the WIPP performance assessment calculations.

The Agency's revision to the PBRINE parameter was incorporated into Sensitivity Study SEN4. The study results indicate the modified PBRINE probability distribution contributed to an increase in estimated direct brine releases and increased the total releases at the 0.001 low probability compliance point to roughly double those in the 2014 Compliance Recertification Application performance assessment.<sup>19</sup> Because the Agency is unable to accept the DOE approach used to define the PBRINE parameter, the EPA views the updated probability distribution used in the SEN4 study as the baseline for PBRINE in future performance assessments. The EPA will evaluate alternative approaches proposed by the DOE. See Section VI.E for more discussion of the SEN4 study.

**e. Revised Corrosion Rate of Steel.** The WIPP corrosion rate model includes anoxic corrosion (i.e., corrosion in the absence of oxygen) of iron in the waste containers. This corrosion is caused by hydrogen sulfide gas produced from the microbial degradation of cellulosic, plastics and rubber materials from the contaminated rubber gloves and Kimwipes™ included in the waste.

The EPA reviewed the 2014 Compliance Recertification Application model and had concerns with the way the model addressed expected repository carbon dioxide concentrations in the experimental derivation of corrosion rates. The EPA also found that the model did not

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<sup>18</sup> "Probability of Encountering Castile Brine Beneath the WIPP Waste Panels Using the TDEM Block Method."

<sup>19</sup> DOE 2014 Appendix PA, Sections PA-9.3 and PA-9.5 Kirchner 2013 and the EPA, 2017 Technical Support Document

incorporate hydrogen sulfide induced steel passivation,<sup>20</sup> which could result in an overestimation of corrosion in the longer-term. Once steel is passivated, hydrogen sulfide consumption will decrease significantly as corrosion will be limited by the ability for the gas to diffuse through the iron sulfide coating the outer surface of the container.

In addition, other components of this model, which the DOE considered to be minor, may have more impact. Calculations of the potential lead inventories at the WIPP only include current waste containers without accounting for the maximum potential of future containers.

To address the EPA's concerns about corrosion, part of the DOE's SEN4 sensitivity study involved turning off the hydrogen sulfide corrosion parameter to simulate steel passivation. These changes resulted in a slight increase in gas pressures as well as a decrease in the saturation of the waste area because both hydrogen gas and water were eliminated from the end products. Results from this study indicated that projected releases would remain within the limits of 40 CFR 191.13. Therefore, the EPA accepts the corrosion approach incorporated in the 2014 Compliance Recertification Application. See Section VI.E for more discussion of the SEN4 study.

To ensure that future performance assessments adequately address the mechanisms that affect gas generation in the repository, it would be appropriate for the DOE to update the corrosion model to better address steel passivation and account for radiolysis and address lead corrosion to be consistent with the expected inventory of the repository.

**f. Revised Effective Shear Strength of the WIPP Waste.** The parameter TAUFAIL represents waste shear strength and is used in calculating potential releases of waste materials from the WIPP repository when a drilling operator drills a borehole through the waste.

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<sup>20</sup> Passivation refers to the creation of an outer coating layer on the steel canisters due to the interaction of iron and sulfide.

The drilling mud will apply a hydrodynamic shear stress to the punctured waste and cause it to erode and be transported up the borehole to the surface. The sheared waste transmitted to the surface is called “cavings”. A higher shear strength means the material is less likely to break into pieces and be transported up a borehole. The parameter TAUFAIL has an uncertain value which is sampled from a range of experimental values for individual model runs. In the 2014 Compliance Recertification Application, the DOE updated the mean and lower bound for the TAUFAIL parameter value distribution based on a suite of laboratory flume tests specifically designed to represent the range of values for the WIPP waste.

In the 2009 Compliance Recertification Application the lower bound value was 0.05 Pa, while for the 2014 Compliance Recertification Application the lower bound of the distribution was increased to 2.22 Pa (the mean value from the laboratory flume tests). The upper bound of the distribution, 77 Pa, remained the same. The EPA believes the DOE’s overall approach of using experimental data to revise the TAUFAIL parameter is reasonable; however, the EPA had concerns with the DOE’s lower “bounding” range value derived from the experiments. The Agency was concerned that three of the five low shear-strength tests had highly scattered results. The DOE attributed the scatter to pre-test sample damage and/or a high degree of variability in sample preparation, rather than testing an equivalent suite of samples. As a result, the mean of the low shear strength test results may not be truly representative of low shear strength samples.

In the SEN4 study, the EPA requested the DOE include the lowest shear-strength flume test results (1.6 Pa) as the bounding value, rather than the average (2.22 Pa). The SEN4 results indicate modifying the lower range to include the lowest value as the bounding value insignificantly impacted releases. This is due to the fact that the change from 2.22 Pa to 1.6 Pa (i.e., from the mean of experimental values to the lowest experimental value) is much less than



would be the change from the 0.05 Pa used in previous performance assessments to either the 1.6 Pa or the 2.22 Pa values. Based on these results, the EPA accepts the DOE's range of values used in the 2014 Compliance Recertification Application, though for future performance assessments the EPA believes it is more appropriate for the DOE to use the lower-bound result instead of the mean. See Section VI.E for more discussion of the SEN4 study. See also the TAUFAIL TSD.<sup>21</sup>

**g. Revised Repository Water Balance.** Repository water balance is the culmination of multiple chemical reactions that produce or consume water and affect actinide concentrations in the brine. These reactions include microbial degradation of the cellulosic, plastic and rubber materials, the anoxic corrosion of iron in the steel waste canisters, and reactions of the magnesium oxide (MgO) used to control carbon dioxide (CO<sub>2</sub>) buildup in the repository. Magnesium oxide, in particular, reacts with brine and results in hydromagnesite (Mg<sub>5</sub>(CO<sub>3</sub>)<sub>4</sub>(OH)<sub>2</sub>·4H<sub>2</sub>O), which consumes water in the process.

Previous compliance recertification applications only included anoxic corrosion in water balance calculations. The 2014 Compliance Recertification Application includes an assessment of the microbial degradation of the cellulosic, plastic and rubber material, the anoxic corrosion of iron in the steel waste canisters and reactions of the engineered barrier. The DOE did not change the rates for microbial cellulosic, plastic and rubber material degradation and water production from the 2009 Compliance Recertification Application. As discussed previously, the DOE revised steel corrosion rates. The DOE developed magnesium reaction rates for the compliance recertification application based on previous studies (Chemistry TSD<sup>22</sup>).

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<sup>21</sup> "Technical Support Document for Section 194.23: EPA Review of Proposed Modification to the Waste Shear Strength Parameter TAUFAIL" in Docket ID No. EPA-HQ-OAR-2014-0609.

<sup>22</sup> "Technical Support Document for Section 194.24: Evaluation of the Compliance Recertification Actinide Source Term, Gas Generation, Backfill Efficacy, Water Balance and Culebra Dolomite Distribution Coefficient Values" in Docket ID No. EPA-HQ-OAR-2014-0609.

Although changes to each of these parameters is minor, the reactions will have a cumulative effect. Based on previous exchanges with the DOE (see comment 2-C-5 in Docket ID No. EPA-HQ-OAR-2014-0609) as well as the SEN4 sensitivity study, the water balance updates do not appear to significantly affect the WIPP performance. However, the EPA recommends that the DOE re-evaluate the water balance issue for future performance assessments to address questions associated with interactions involving magnesium oxide (e.g., hydration rates in the water balance calculations), and as previously discussed in Section VI.D.1.e, the associated steel corrosion model and passivation processes.

**h. Variable Brine Volume.** Brine volume plays an important role in calculating actinide and organic ligand concentrations. In previous performance assessments, the DOE calculated concentrations of these species using the minimum brine volume needed for a direct brine release, regardless of how much brine is projected to be released. This failed to account for dilution and thus resulted in an overestimation of organic ligand concentrations as well as actinide releases. To correct for this in the 2014 Compliance Recertification Application, the DOE adjusted actinide and organic ligand concentration calculations to incorporate multiple brine volumes. The DOE continues to calculate actinides and organic ligand concentrations at the minimum brine volume required for a release. However, the DOE now also calculates concentrations by dissolving these species at volumes 2, 3, 4 and 5 times the minimum volume to simulate larger volume releases. Thus, concentrations at 5 times the volume will be lower than those calculated at the minimum volume because more brine will be present to dilute these aqueous species. The EPA finds that this approach realistically addresses the issue of variable brine volumes involved in a direct brine release and accepts this model for the compliance recertification application.

**i. Revised Colloid Parameters.** Colloids are particles larger than molecules that can be suspended in the WIPP brine. Because colloids migrate more rapidly through the subsurface than actinides dissolved in solution, colloids are an important contribution to actinide mobility during a direct brine release. Intrinsic colloids are actinide macromolecules that eventually increase in size. Microorganisms are considered large colloids capable of mobilizing actinides because of actinide sorption to their charged cell walls or because of actinide bio-uptake.

In the original Compliance Certification Application, the colloid parameters were based on experimentally derived values examining actinide macromolecules or actinides sorbed onto biomass (e.g., Completeness Comment 3-C-9 in EPA-HQ-OAR-2014-0609-0010). Since then, the DOE has performed multiple new investigations to update the intrinsic and microbial colloid parameters. These investigations prompted the DOE to reduce the contribution of colloids in the 2014 performance assessment.

Because of issues with experimental data used to develop the 2014 colloid contributions to actinide solubility, the 2014 performance assessment calculations using those experimental results may underestimate colloidal concentrations, and therefore, actinide solubility. However, the EPA finds that the use of an updated uncertainty distribution for actinide solubility in the SEN4 sensitivity study provides adequate information to determine that an increase in colloid concentrations would not cause releases to exceed the disposal standards. The EPA recommends that additional review of the experimental results would benefit the DOE's treatment of colloid formation mechanisms in future performance assessments. The EPA's review of this topic is provided in the Chemistry TSD. See Section VI.E of this document for discussion of the SEN4 study.

**j. New Actinide Solubility Code (EQ3/6).** Prior to the 2014 Compliance Recertification Application, the DOE used the Fracture Matrix Transport (FMT) geochemical modeling code for actinide solubility calculations. The DOE has since moved actinide solubility calculations to the EQ 3/6 code using the database DATA0.FM1, which contains the values needed to calculate chemical speciation of the ions, actinides and minerals present in the WIPP. The move to EQ3/6 is logical as the program is widespread and has been used in other the DOE projects. EQ3/6 can provide more robust calculations than FMT, particularly in dynamic reaction-path calculations. The EPA accepts the move to the EQ 3/6 code. For additional discussion on this topic see the EQ 3/6 TSD.<sup>23</sup>

**2. Other Key Issues Identified by the EPA During Review.** The EPA identified three key topics where the Agency believes new information can be incorporated into future compliance recertification applications. These topics relate to the chemical conditions within the repository and are of fundamental importance in determining the potential for releases of radionuclides from the disposal system. These topics are discussed in more detail in the Chemistry TSD.

**a. Chemical Database.** Actinide solubility, or the ability for actinide solids to dissolve in brine, is important in calculating releases. In performance assessment calculations, these radionuclides include americium, curium, neptunium, plutonium, thorium, and uranium. Americium(III) solubility is used to predict plutonium(III) and curium(III) concentrations while thorium(IV) is used to predict plutonium(IV), neptunium(IV) and uranium(IV).

The EPA's review identified that the DOE's update of the chemical assumptions used in the actinide solubility database (DATA0.FM1) did not reflect all data available prior to the

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<sup>23</sup> "EQ3/6 Computer Code Evaluation" in Docket ID No. EPA-HQ-OAR-2014-0609.

DOE's data cut-off date of December 31, 2012. The EPA raised several issues (in Docket ID No. EPA-HQ-OAR-2014-0609-0010) about americium and thorium solubility and speciation and in response, the DOE modified the database to produce DATA0.FM2. However, the EPA identified flaws in the modified database that need to be corrected before it can be considered to be of sufficient quality for use in recertification. The EPA concluded that, even with identified data gaps, the original DATA0.FM1 database was of higher quality and provided sufficient information to support a determination of continued compliance. The DOE's updates of the chemical database for future performance assessments should more comprehensively incorporate recent data.

**b. Revised Radionuclide Uncertainty Distribution.** The DOE also examined the uncertainty distribution used to model the +III and +IV actinide concentrations in the performance assessment by comparing modeled solubility calculations to experimental data from multiple reports and peer-reviewed studies. These studies include solubility measurements from americium, thorium and their analogues using a specific set of criteria (Chemistry TSD; 2014 Compliance Recertification Application, Appendix SOTERM-2014 Section 5.1.3). During the performance assessment solubility calculations, this uncertainty distribution is sampled and used in calculating dissolved actinides in a release.

After reviewing the actinide solubility uncertainty distribution for the 2014 Compliance Recertification Application, the EPA identified relevant studies that were not considered in developing this distribution, as well as identifying studies that should have been excluded from consideration, based on the DOE's evaluation criteria. Using relevant studies would result in a revised actinide solubility uncertainty distribution with overall higher +III actinide solubility. The DOE included a revised solubility uncertainty distribution based on the EPA's input in the

sensitivity study SEN4. The higher actinide solubility used in the SEN4 study contributed to higher releases compared to the 2014 performance assessment, although releases in the SEN4 study still remain below the regulatory limits. See Section VI.E for more discussion of the SEN4 study.

The EPA recommends that updating the actinide solubility uncertainty distribution should be part of the update to the geochemical database. This would include incorporating new solubility data for thorium and americium under the WIPP repository conditions, and re-evaluating how studies are included in or excluded from the DOE's analyses.

**c. Plutonium Oxidation State.** Oxidation states refer to an actinide ion's charge. Actinides with a higher charge likely exist in environments with greater oxygen content while actinides with lower charges likely exist where there is less oxygen. Although plutonium has multiple oxidation states including +VI, +V, +IV, and +III, the WIPP model assumes plutonium oxidation state is dominated by the +III or +IV charge in the aqueous phase due to the rapid removal of oxygen in the repository. Identifying the dominant oxidation state is particularly important as plutonium(III) is much more soluble than plutonium(IV). To address this uncertainty, the plutonium oxidation state model does not calculate oxidation state but instead considers plutonium(III) in 50% of the realizations and plutonium(IV) in the other 50%. Since the 2009 Compliance Recertification Application, experiments have verified that the iron metal corrosion of the WIPP waste containers largely mediate the conditions conducive to plutonium(IV) and plutonium(III) oxidation states. While experiments have confirmed the WIPP conditions post-closure, the debate has shifted towards whether plutonium(IV) or plutonium(III) is dominant in the WIPP conditions, or whether they will be present in equal proportions. More recent experimental information leads the EPA to believe that, under the WIPP conditions,

aqueous plutonium(III) will be the dominant state of plutonium and will exist in equilibrium with the different solid plutonium phases present. In addition, organic ligands, iron and microbial processes will also increase the likelihood that plutonium(III) will dominate in solutions.

While the sensitivity studies did not directly test the presumption that +III and +IV species would be equally present, the SEN4 study indirectly examined this proposition by including a modified solubility uncertainty distribution that was more heavily weighted toward higher +III solubility (see Section VI.E.2.d). Both the compliance recertification application and the SEN4 study indicate plutonium release levels will be below the compliance points. Combined with the related analysis of the actinide solubility uncertainty distributions, the Agency can accept the DOE's assumption that the plutonium(III) and plutonium(IV) oxidation states will each occur 50% of the time in performance assessment calculations for the current recertification. However, because of the available data that the EPA has identified supporting the presence of plutonium(III) over plutonium(IV), the EPA believes this issue is of sufficient significance to benefit from independent technical review of the available data and the assumption that both plutonium oxidation states will occur equally under the WIPP conditions. The EPA's review of the plutonium oxidation state issue is addressed more thoroughly in the Chemistry TSD.

**E.     *Performance Assessment: Modeling and Containment Requirements (§§194.14, 194.15, 194.23, 194.31 through 194.34)***

**1.     Overview.** Section VI.A provided a basic description of the requirements in 40 CFR 191.13 and the performance assessment process required to show compliance with those standards. This section provides additional information on performance assessment and how it is evaluated by the EPA in the compliance recertification application. As described earlier, the

DOE must use the performance assessment to demonstrate compliance with the containment requirements in 40 CFR 191.13. The containment requirements are expressed in terms of “normalized releases.” The DOE assembles the results of the performance assessment into complementary cumulative distribution functions, which indicate the probability of exceeding various levels of normalized releases (§194.34).

For both of the DOE’s 2004 and 2009 Compliance Recertification Applications, the EPA requested that the DOE modify those respective performance assessments to 1) address completeness and technical issues raised during the EPA review process and with these modifications, and 2) assure the disposal regulations were met.

These additional sets of calculations have been termed by the DOE to be performance assessment “baseline calculations” and the EPA has considered these calculations as updated “baselines” for each respective compliance recertification application. The EPA then used these baseline calculations for the comparison performance assessment in each of the DOE’s subsequent five-year compliance recertification applications.

In this recertification review process, the Agency proceeded differently than in the past. During the completeness review, the EPA identified issues with parameters or approaches used by the DOE in the calculations. These have been discussed in Section VI.D. The Agency requested that the DOE conduct additional calculations so the EPA could better understand how alternative parameter values would affect repository performance. These calculations, or sensitivity studies as they have been referred to, are summarized below and are the subject of a TSD.<sup>24</sup> With the completion of these sensitivity studies, the Agency has decided not to request another set of performance assessment baseline calculations as was done for previous

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<sup>24</sup> “Review of EPA Sensitivity Studies of the DOE CRA-2014 WIPP Compliance Recertification Performance Assessment” in Docket ID No. EPA-HQ-OAR-2014-0609.



recertifications. The Agency believes that the sensitivity studies, coupled with the DOE's documentation, provide a reasonable expectation that the WIPP complies with the radioactive waste disposal regulations at 40 CFR part 191 and the compliance criteria at 40 CFR part 194. Further, with the February 2014 incidents and the DOE's resulting need to change the facility design<sup>25</sup>, the Agency felt it was not necessary or appropriate at this time to conduct additional calculations using a facility design that will be changed in the near future.

The Agency requested that the DOE conduct four sensitivity studies (labeled as SEN1, SEN2, SEN3 and SEN4) to address technical concerns raised during the EPA's 2014 Compliance Recertification Application review. The EPA has compared these sensitivity results to the DOE's 2014 performance assessment calculations. The purpose of these sensitivity studies is to provide an understanding of how repository compliance would be affected when modifying specific inputs in the 2014 performance assessment calculations. A brief explanation of those selected parameters is provided below.

The ability of salt openings and aggregates to quickly compress, consolidate and "heal" within a few hundred years, mostly due to the creep-closure process, is one of the unique properties of bedded salt geologic units that make them potentially suitable to use as nuclear waste repositories. The DOE's 2014 performance assessment parameter values assigned to the non-waste rooms, the panel closure system and the adjacent disturbed rock zone did not reflect the creep-closure and rapid healing of these areas that the EPA expects to occur. That is, the DOE did not use permeability, porosity, residual gas and brine saturations and capillary pressures reflective of in-situ (i.e., undisturbed) conditions.

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<sup>25</sup> The DOE has stated that it intends to abandon plans to use the area previously designated as waste panel 9 for waste emplacement because of worker safety issues ("Installation of Ventilation Barriers and Prohibiting Personnel Access to Equivalent Panel 9 Areas," Letter from Todd Shrader, DOE, to Alan Perrin, EPA dated April 18, 2017, Docket ID No. EPA-HQ-OAR-2014-0609). The DOE also plans to develop a new ventilation shaft to increase airflow in the mine, which is limited after the February 2014 incidents.

Three of the EPA requested sensitivity studies, SEN1, SEN2 and SEN3, focused on modifying parameters to test how assuming complete creep-closure and healing of these areas would impact long-term performance through modifying values related to the permeability, porosity and two-phase flow parameter values for the run-of-mine salt panel closure system, the disturbed rock zone and non-waste areas for the 10,000-year modeled period. The fourth sensitivity study, SEN4, investigated the cumulative effects and impact on repository performance by making changes to five important parameter values as well as using an updated numerical code.

As with the 2014 performance assessment, all of the sensitivity studies had three replicate calculation sets and included the same future scenarios. The four scenarios are briefly described below:

- 1) The undisturbed scenario—where the repository is not impacted by human activities,
- 2) The E1 Scenario—where one or more boreholes penetrate a Castile brine reservoir and also intersect a repository waste panel,
- 3) The E2 Scenario—where one or more boreholes intersect a repository waste panel but not a brine reservoir, and
- 4) The E1/E2 Scenario—where there are multiple penetrations of waste panels by boreholes of either the E1 or E2 type, at many possible combinations of intrusion times and locations for either E1 or E2 drilling type of event.

## **2. Sensitivity Studies.**

**a. The SEN1 Study.** The intention of the SEN1 study was to determine the impact on repository performance by modeling the stepped (i.e., gradual) reduction in porosity, permeability, residual gas and brine saturation, and capillary pressures that reflect creep-closure

and healing of the open rooms and disturbed rock zone during the first 200 years after repository closure. The DOE was then to model these areas, from 200 years to 10,000 years, as fully healed.

This study had to be terminated because the numerical flow code used in these calculations produced non-physical and unrealistic results when these parameters were modified in time-intervals to reflect healing. The Agency accepted termination of this study, in part, because modeling changes in these values for the first 200 years, a relatively short time compared to the 10,000-year regulatory time period, would not be as important to long-term repository performance. The Agency considered that the SEN2 and SEN3 studies described below adequately addressed the issues targeted by the SEN1 study because the latter two studies both modeled the open and disturbed areas as fully healed for the entire 10,000-year regulatory time period, essentially bounding the conditions specified for the SEN1 study.

**b. The SEN2 Study.** This study tested the impacts on repository performance by modeling the non-waste areas and open drifts as completely creep-closed during the entire 10,000-year regulatory period. In this study, parameter values for all the non-waste areas (i.e., the operations and experimental room open drifts) and adjacent disturbed rock zones were modified. The permeability and porosity were reduced to that of intact halite. The residual brine and gas saturations were also increased to better reflect healed conditions and capillary pressures (the pressure needed for fluid to flow between pores) were increased.

Compared to the 2014 Compliance Recertification Application performance assessment, the SEN2 study waste room pressures generally increased and brine saturations decreased. The most affected primary release mechanism saw an increase in solid waste moving up a borehole (spallings) because this release mechanism increases when waste panel pressure increase. All other release mechanisms remained essentially unchanged from the 2014 performance

assessment calculations. Total spillings releases remained small compared with cuttings, cavings and direct brine releases. Spallings releases therefore did not materially contribute to total repository releases in either SEN2 or the 2014 Compliance Recertification Application.

**c. The SEN3 Study.** For the SEN3 study, the DOE assumed that the panel closure system, the adjacent disturbed rock zone and the non-waste areas and open drifts are healed for the 10,000-year regulatory period. The DOE reduced porosity and permeability in the repository, increasing initial residual brine and gas saturations, and invoking two-phase flow parameters for intact halite. Using these modifications effectively isolated the individual waste panels and the non-waste areas from one another for the entire modeled period due to limited brine and gas flows between areas of the repository.

The modifications made in the SEN3 study caused increases in waste-panel pressures and decreases in waste panel saturations. The dominant releases were from spillings, which are only dependent on a waste panel pressure high enough to force solids to the surface, and direct brine releases, which are dependent on having sufficient brine in the waste panels coupled with high enough pressure to force brine to the surface. The release mechanism that increased the most was for spillings, and the increase was seen at both the low and high probability compliance points. The impact on direct brine release was primarily at low probabilities because this release depends on both high waste panel pressure and high saturation conditions, the combination of which were less likely to occur in this study.

Factoring in all combined releases, the total mean and low-probability (0.001 probability) releases increased by approximately 15% from the initial 2014 Compliance Recertification Application results, although the upper bound of the 95% confidence interval was essentially the same as in the 2014 Compliance Recertification Application (0.384 EPA Units in the 2014

Compliance Recertification Application and 0.387 EPA Units in SEN3). Total releases did not exceed the EPA's WIPP release limits.

The parameter values used in the SEN3 study created a "tight" repository (panel closure system, disturbed rock zone and non-waste rooms) in which brine and gas flow is limited. The study results indicate that such conditions may produce calculated releases higher than the more open and brine- and gas-conductive set of conditions presented by the DOE in the 2014 Compliance Recertification Application.

**d. The SEN4 Study.**

**i. Overview.** The fourth sensitivity study was intended to understand the cumulative effects on repository performance by making changes to several parameters that the Agency questioned in the completeness review. This study also incorporated a DOE-corrected version of the DRSPALL code, which calculates waste that is released up a borehole to the surface. This study does not address all of the EPA's completeness questions, but provides significant insights as to the degree in which some parameter values of interest to the EPA impact releases. Note, the parameter changes in SEN2 and SEN3 representing creep closure were not made in the SEN4 study, so the results reflect the 2014 Compliance Recertification Application creep closure assumptions. The modifications requested for this study are provided below:

- Use the EPA's updated distribution for the probability of intersecting a waste panel and a Castile brine reservoir, denoted as the PBRINE parameter and discussed in Section VI.D.1.d previously.
- Use the revised data set for the plutonium oxidation state uncertainty distribution discussed in Section VI.D.2.c.

- Modify the lower limit for the parameter that predicts waste strength, denoted as the parameter TAUFAIL discussed in Section VI.D.1.f.
- Use the updated version of the computer code DRSPALL that models waste carried up a borehole. After the 2014 performance assessment calculations had been completed and submitted to the EPA, the DOE discovered an error in the computer code, DRSPALL. The DOE corrected this error and reported it to the EPA. For the SEN4 study, the EPA requested that the DOE use the corrected version.
- Eliminate the hydrogen sulfide reaction with iron as discussed in Section VI.D.1.e.
- Use the correct modeled length for north panel closure. The WIPP repository design includes two sets of panel closures emplaced at the north end of the repository. For the 2014 performance assessment calculations, the DOE modeled the “effective” length of only one panel closure rather than two. The EPA requested that the DOE increase the effective length of the modeled north waste panel to be consistent with the facility design.

**ii. Cumulative effects of the changes evaluated by release pathway.**

**aa. Direct Brine Releases.** Direct brine releases are a function of actinide solubility, repository pressure and brine saturation. Of these changes, the most significant are the revised solubility uncertainty distributions that increase the concentration of the more soluble plutonium(III) in repository brine, the increased likelihood of a higher probability of hitting a brine pocket and the iron sulfidation reaction stoichiometric coefficient changes. The combined effects of these changes increased direct brine calculated releases and total mean low probability (0.001) repository releases to about twice those of the 2014 Compliance Recertification Application performance assessment (0.541 EPA Units for SEN4 versus 0.261 EPA Units for 2014 performance assessment).

**bb. Spallings Releases.** Spallings releases are affected in SEN4 by a combination of corrections using the updated version of the DRSPALL code as well as increases in repository pressure. Repository pressure was generally increased in SEN4 as a result of the updated distribution of the PBRINE parameter, the increased length of the northernmost panel closure and the updated iron sulfidation reaction stoichiometric coefficients. The combined effect of these changes was to increase spallings releases by about half an order of magnitude. However, spallings releases remained low compared to direct brine releases and the effect of this increase in spallings on total mean releases was minimal.

**cc. Cuttings and Cavings Releases.** Cavings releases were affected by the Agency's requested reduction of the lower bound of the distribution for the TAUFAIL parameter. The small reduction in the lower bound did not have a meaningful effect on total mean releases.

**dd. Releases from the Culebra.** Releases from lateral flow through the Culebra Dolomite are a function of actinide solubility, repository pressure, and brine saturation. These are affected by the revised solubility uncertainty distributions, the increased likelihood of sampling higher values for the PBRINE parameter, the increased length of the northernmost panel closure and removal of the iron sulfidation reactions. The combined effect of these changes on Culebra releases was too small to have a meaningful effect on total mean repository releases.

**ee. Insights from the SEN4 Study.** In the SEN4 study, the most significant effects on repository performance were an increase in direct brine releases and, by extension, an increase in total low probability repository releases. The Agency concludes that these increases were primarily the result of updating the solubility uncertainty distributions, updating the distribution of PBRINE and incorporating hydrogen sulfide steel passivation. The remaining

changes, updating the TAUFAIL lower bound, using the corrections in the code DRSPALL and correcting the panel closure length, provided important updates and corrections to the performance calculation but had only a negligible effect on total mean releases. As in the previous sensitivity studies, the total mean releases, the upper 95% confidence limit on those means and all individual vectors in the three replicates remained below regulatory limits in SEN4.

**3. How the Four Sensitivity Studies Affect the WIPP's Compliance.** The results indicate that modifications to the selected parameters reported in these evaluations increased calculated releases. However, the total mean releases, the upper 95% confidence limit on those means, and all individual vectors in the three replicates remained below the EPA's WIPP release limits.

These sensitivity studies were intended to address a subset of the EPA technical issues. These studies do not address all the technical issues identified in the EPA's 2014 Compliance Recertification Application review. The major issues identified in the EPA's review primarily influence the direct brine releases and how the performance assessment addresses those releases. The EPA recommends that, especially with respect to calculating direct brine releases, the DOE re-evaluate the implementation of features, events and processes, along with model assumptions, to ensure their appropriate integration in the 2019 Compliance Recertification Application. The EPA has identified two areas in particular (modeling of open areas and plutonium oxidation states) that the Agency believes would greatly benefit from independent technical review for consideration in the DOE's 2019 Compliance Recertification Application.

***F. Additional Requirements***



This section summarizes the EPA's review as it relates to specific sections of the WIPP Compliance Criteria in 40 CFR part 194 that do not directly involve performance assessment.

Information on continuing compliance activities related to waste characterization (40 CFR 194.8 and 194.24), inspections (§194.21) and quality assurance (§194.22) may be found in Section V of this document.

The DOE did not conduct any activities during the period covered by the 2014 Compliance Recertification Application related to future state assumptions (§194.25), expert judgment (§194.26) or assurance requirements (§194.41-46). See the corresponding CARDS for more discussion. Information on passive institutional controls, which is an element of the assurance requirements, may also be found in Section V.B.4.

**1. Waste Characterization (Waste Inventory) (§194.24).** Section 194.24 generally requires the DOE to identify, quantify and track the important chemical, radiological and physical components of the waste destined for disposal at the WIPP. The DOE collects data from generator sites and compiles the waste inventory on an annual basis. The DOE's 2012 Annual Transuranic Waste Inventory Report (ATWIR 2012), which was used for the 2014 Compliance Recertification Application, reflects the disposal intentions of the waste generator sites as of December 31, 2010. The DOE classified the wastes as emplaced, stored or projected (to-be-generated). The DOE used data from the WIPP database to identify the characteristics of the waste that has been emplaced at the WIPP. The projected wastes were categorized similarly to existing waste (e.g., heterogeneous debris, filter material, soil).

The EPA reviewed the compliance recertification application and supplemental information to determine whether these documents provided a sufficiently complete estimate and description of the chemical, radiological and physical composition of the emplaced, stored and

projected wastes proposed for disposal in the WIPP. The Agency also reviewed the DOE's description of the approximate quantities of waste components (for both existing and projected wastes). The EPA found that the radionuclides, cellulosic, plastic and rubber materials, organic ligands, oxyanions and cements in the waste are being appropriately tracked and characterized. In the 2014 Compliance Recertification Application, there is an update on the inventory of curium and neptunium, which remain in concentrations well below their solubility limits even after accounting for decay. The EPA accepts this updated inventory, which is relatively similar to the one used in the 2009 Compliance Recertification Application. See the Baseline Inventory TSD<sup>26</sup> for more information.

**2. Peer Review (§194.27).** Section 194.27 of the WIPP Compliance Criteria requires the DOE to conduct peer review evaluations, when warranted, of conceptual models, waste characterization analyses, and a comparative study of engineered barriers. The required peer reviews must be performed in accordance with the Nuclear Regulatory Commission's NUREG-1297, "Peer Review for High-Level Nuclear Waste Repositories," which establishes guidelines for the conduct of a peer review exercise. The DOE has conducted one peer review since the 2009 Compliance Recertification Application to establish radiological properties for two waste streams, titled the "Savannah River Site Historical Radiochemistry Data Peer Review," demonstrating its compliance with the requirements of §194.27.

Based on a review and evaluation of the 2014 Compliance Recertification Application and supplemental information provided by the DOE (Docket ID No. EPA-HQ-OAR-2014-0609-0330), the EPA determines that the DOE continues to comply with the requirements of 40 CFR 194.27.

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<sup>26</sup> "Technical Support Document for Section 194.24: Review of the Baseline Inventory Used in the Compliance Recertification Application (CRA-2014)" in Docket ID No. EPA-HQ-OAR-2014-0609.

***G. Individual and Groundwater Protection Requirements (§§194.51 through 194.55)***

Sections 194.51 through 194.55 of the WIPP Compliance Criteria implement the individual protection requirements of 40 CFR 191.15 and the groundwater protection requirements of subpart C of 40 CFR part 191. Assessment of the likelihood that the WIPP will meet the individual dose limits and radionuclide concentration limits for ground water is conducted through a process known as compliance assessment. Compliance assessment uses methods similar to those of performance assessment (for the containment requirements in 40 CFR 191.13 and Appendix A) but is required to address only undisturbed performance of the disposal system. That is, compliance assessment does not include human intrusion scenarios (i.e., drilling or mining for resources). Compliance assessment can be considered a “subset” of performance assessment, since it considers only natural (undisturbed) conditions and past or near-future human activities (such as existing boreholes), but does not include the long-term future human activities that are addressed in the performance assessment.

In the 2014 Compliance Recertification Application, the DOE re-evaluated each of the individual and groundwater requirements. The DOE updated the data for ground water quantity determination to define an underground source of drinking water for purposes of calculating groundwater concentrations and doses. In the 2014 Compliance Recertification Application, the DOE used 2011 (U.S. Bureau of Census 2013) census data to update the number of persons per household.<sup>27</sup> The DOE continued to use the 2009 compliance recertification application data for the average household water consumption values. The water consumption data show that the average per capita consumption is 273 gallons per day.<sup>28</sup> The DOE concludes that the sub-criterion of 5 gallons per minute rate of production from a well continues to accurately define an

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<sup>27</sup> 2014 Compliance Recertification Application Appendix IGP-2014, Table IGP-3

<sup>28</sup> 2014 Compliance Recertification Application Appendix IGP-2014, Table IGP-3

underground source of drinking water<sup>29</sup> and any change in this sub-criterion is not warranted as a result of applying more current water-consumption data to the calculation.

The updates made by the DOE in the 2014 Compliance Recertification Application did not significantly impact the conclusions regarding the groundwater standard in the Compliance Certification Application. The DOE did not change the criteria for making underground source of drinking water determinations, and for the 2014 Compliance Recertification Application evaluation, the maximum potential dose remains below the Compliance Certification Application value calculated and continued compliance with the individual protection standard is maintained. The DOE states that the conservative bounding analysis used for the 1998 certification decision compliance assessment is still applicable for 2014 Compliance Recertification Application.<sup>30</sup>

The EPA finds the DOE in continued compliance with 40 CFR 194.51-194.55 requirements.

## **VII. How has the public been involved in the EPA's WIPP Recertification activities?**

### ***A. Public Information***

The EPA interacts with the public through various means. The EPA's main mechanism for distributing information is the EPA website and e-mail messages via the WIPP-NEWS listserv. The EPA will also occasionally have meetings, in person or via teleconferences or webinars.

Throughout the recertification process, the Agency posted pertinent new information and updates on the EPA WIPP website (<https://www.epa.gov/radiation/epas-role-waste-isolation-pilot-plant-wipp>). All pertinent recertification documents (including the DOE-submitted recertification materials, correspondence, Federal Register notices, outreach materials, hearing

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<sup>29</sup> 2014 Compliance Recertification Application Appendix IGP-2014, Section IGP-3.1.1)

<sup>30</sup> 2014 Compliance Recertification Application Appendix IGP-2014, Section IGP-4.0

transcripts as well as TSDs) are available for review or download (in Adobe PDF format) via the electronic docket dedicated to the 2014-2017 recertification process (<http://www.regulations.gov>, Docket ID No. EPA-HQ-OAR-2014-0609).

Since October 2014, the EPA has sent out numerous announcements regarding the recertification schedule and availability of any WIPP-related documents on the EPA WIPP website and the dockets, as well as details for the Agency's June 2015 stakeholder meetings in New Mexico and January 2017 stakeholder webinar (via Adobe Connect).

#### ***B. Stakeholder Meetings***

As discussed in the WIPP LWA, the recertification process is not a rulemaking and public hearings are not required. However, the EPA held a series of stakeholder meetings in June 2015 (Carlsbad and Albuquerque, NM) as well as a stakeholder webinar in January 2017 (via Adobe Connect software, with public hosting locations in Carlsbad and Albuquerque, NM) to provide information and updates about the recertification process. In an effort to make these meetings as informative as possible to all attending parties, the EPA listened to stakeholder input and concerns and tailored the meetings around the public as much as possible. The first meeting was held on June 16, 2015, in Carlsbad, New Mexico and consisted of one three-hour afternoon session. The second public meeting was held on June 17, 2015, in Albuquerque, New Mexico, with afternoon and evening sessions.

The main purpose of these meetings was to discuss the EPA's recertification process and timeline, as well as the DOE's application and important changes at the WIPP since the last recertification in 2010. The meetings featured brief presentations on the aforementioned topics, as well as a facilitated discussion. In response to stakeholder suggestions, the DOE staff members were also on hand to provide information and answer any stakeholder questions. Staff

from the New Mexico Environment Department (NMED) were present as observers. Public participants were encouraged to provide comments to the EPA for consideration during review of the DOE's 2014 Compliance Recertification Application.

The EPA also held a stakeholder webinar using the Adobe Connect software on January 12, 2017. The Agency hosted the webinar from Washington, DC, with physical hosting locations set up in both Carlsbad and Albuquerque, NM, to accommodate members of the public as well as the DOE and NMED staff. The main purpose of this webinar was to inform the public of the current recertification schedule and provide updated technical information related to stakeholder questions and comments received at the June 2015 meetings.

All of the issues raised at these meetings have been addressed by the EPA in Section VII.C of this document or in the CARDS under the relevant section and are available in the public docket ([www.regulations.gov](http://www.regulations.gov), Docket ID No. EPA-HQ-OAR-2014-0609).

### **C. *Public Comments on Recertification***

The EPA posted the recertification application on the website immediately following receipt. The EPA formally announced receipt of the recertification application in the Federal Register on October 10, 2014. The notice also officially opened the public comment period on the recertification application.

For recertification, the EPA sought public comments and input related to changes in the DOE's application that may have a potential impact on the WIPP's ability to remain in compliance with the EPA's disposal regulations.

The comment period for the recertification application closed on April 10, 2017, approximately two years and six months after it initially opened. This closing date was 30 days

after the EPA's announcement in the Federal Register that the recertification application was complete.

The EPA received 17 sets of written public comments during the public comment period. The EPA considered significant comments from the written submissions and the stakeholder meetings in the evaluation of continuing compliance. The EPA addresses these comments in CARDS that are relevant to each topic. In addition, a listing of all comments received and responses to each is included in Appendix 15-C of CARD 15. Two specific comments are addressed here.

*Comment:* One comment addressed shipment of waste from Argonne National Lab. Citing the EPA's inspection reports, the commenter stated that he believed that the DOE had shipped and emplaced at the WIPP waste from the Lab that contained spent nuclear fuel and high level waste. He correctly stated that the WIPP LWA bans the transport to and disposal at the WIPP of high level radioactive waste and spent nuclear fuel. He wanted to know (a) how the EPA failed to uncover that the Argonne Lab was to ship spent nuclear fuel to the WIPP and approved this disposal, (b) how the EPA assures that this waste will not be sent to the WIPP, (c) how much of this waste has been sent to the WIPP, and the identity of all waste of these types, (d) what authority allowed the shipment and disposal of these prohibited wastes, and (e) how the EPA did not bar the DOE's shipment and disposal of these wastes.

In a related comment, on February 3, 2017, the DOE, responded to this commenter and stated that the Argonne Lab waste is derived from atomic energy defense activities and did not contain any spent nuclear fuel (see EPA-HQ-OAR-2014-0609-0042). The DOE acknowledged that the WIPP LWA prohibits the disposal at WIPP of spent nuclear fuel and also acknowledged that some of the waste from the Argonne Lab was debris from specimens taken from fuel pins

that were originally irradiated in commercial nuclear reactors. However, the DOE commented that the statutory definition of spent nuclear fuel does not speak directly to the issue of whether debris from specimens of commercial fuel rods is spent nuclear fuel. The DOE explained that, here, the debris—although including material that originated from fuel pins that had been irradiated in nuclear reactors—resulted from research and development activities at Argonne. The DOE stated that to try to segregate debris originating from irradiated fuel pins from other waste would be technically infeasible and cost prohibitive and would increase worker exposure. The DOE asserted that resolution of whether the material should be considered spent nuclear fuel was within its discretion and that it was its longstanding practice to classify such debris as waste and not spent nuclear fuel. In response to the DOE’s February 3, 2017 comment, the original commenter resubmitted his original comment.

*EPA Response:* Under the WIPP LWA, the focus of the EPA’s present recertification determination is whether the WIPP continues to comply with the final disposal regulations. Although—as the commenter notes and the DOE acknowledges—the WIPP LWA bans disposal at the WIPP of spent nuclear fuel, the disposal regulations, themselves, currently do not expressly address disposal of spent nuclear fuel. The WIPP LWA incorporates the definition of spent nuclear fuel found in the Nuclear Waste Policy Act of 1982: “fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing.” 42 U.S.C. § 10101(23) (as incorporated by WIPP LWA § 2(15)). There seems to be no dispute that waste from the Argonne Lab includes some quantity of material that is not presently in the intact physical form of fuel withdrawn from a reactor



following irradiation,<sup>31</sup> but is fragments of or particulates from fuel pins withdrawn from a reactor following irradiation. The DOE states that the fragments or particulates resulted from research and development activities on test specimens from fuel pins withdrawn from a reactor following irradiation and claims that treatment of such material as other than spent nuclear fuel is consistent with the intent of the WIPP LWA. The DOE also asserts that attempting to segregate the fuel pin fragments and particulates from other debris shipped to the WIPP is infeasible and cost prohibitive and would increase worker exposure.

Reasonable contentions may be made that fragments and particulates resulting from research and development activities on specimens from fuel withdrawn from a nuclear reactor following irradiation (“pieces of pieces” of fuel pins) do not meet the statutory definition of spent nuclear fuel. The practical considerations of feasibility, cost, and worker safety associated with attempting to segregate such particulates from other waste shipped to the WIPP bear consideration. It is not essential, however, to the EPA’s present recertification decision to attempt to definitively resolve this issue, because the current disposal regulations do not expressly address disposal of spent nuclear fuel.

On an on-going basis, aside from the periodic recertification of the WIPP, the EPA communicates with the DOE concerning the characterization of WIPP waste. The DOE provides the EPA with documentation relating to WIPP waste streams, including but not limited to, waste from the Argonne National Laboratory, and including documentation for both contact handled and remote handled TRU waste streams. The relevant information is confirmed by analyzing individual waste containers using the EPA approved processes, procedures and equipment. These steps allow the DOE to demonstrate that waste containers for WIPP disposal

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<sup>31</sup> There also seems to be no doubt that, as to the material in question, the “constituent elements” have not been “separated by reprocessing.”

meet the EPA's WIPP waste limits for physical and radiological contents of the waste. So, concerning the waste shipped from Argonne National Laboratory, the EPA evaluated the waste characteristic information prepared for remote handled waste. The DOE provided historical information to document that waste generated from laboratory experiments at Argonne was defense related, and through radiological assay concluded that the waste in question met the definition of TRU waste and was appropriate for disposal at the WIPP. Following this determination, Argonne provided this waste for characterization. Radiological and physical characterization confirmed that the TRU waste in question (a) is remote handled waste; (b) exhibits the characteristics of debris waste; and (c) meets the regulatory limits of the EPA's WIPP waste acceptance requirements at 40 CFR 194.24.

The EPA thoroughly inspects and approves the waste characterization processes in place at all waste characterization sites including Argonne National Laboratory. As part of the waste characterization inspections and approvals, the EPA is responsible for evaluating the adequacy of characterization methods used to identify and measure radiological and physical contents of the TRU waste that affect the long term containment and isolation of waste at the WIPP and for ensuring that the WIPP-bound waste meets the disposal requirements under 40 CFR 194.24.

*Comment:* Another commenter disagreed with the DOE's proposed revision of the PBRINE parameter. The commenter noted that the DOE's 2014 approach resulted in a lower probability of intersecting a brine pocket than was used in the original certification and previous recertifications, and finds this to be "invalid." The commenter recommends using a fixed value of 60% probability, based on historical well testing and geophysical data. The commenter also disputes a number of the DOE's underlying assumptions for revising the approach, including the

DOE's view of the geophysical data as unreliable and what the commenter sees as the DOE's misinterpretation of more recent drilling data.

*EPA Response:* The EPA agrees with the commenter that the DOE's revised approach raises concerns. In particular, the EPA does not agree with the DOE's conclusions regarding the geophysical data. However, after reviewing the data again, the EPA disagrees with the commenter that a fixed probability of 60% is necessary. The EPA notes that 60% was the high end of the probability distribution used in performance assessments prior to 2014, with a mean probability of 30.5%, as recognized by the commenter. The updated approach developed by the EPA uses the geophysical data, but also incorporates newer drilling information into the probability distribution. The EPA believes this approach is sound and is acceptable for use in future performance assessments. The EPA will evaluate future proposals by the DOE to update the method for determining PBRINE. The EPA's review is discussed further in Section VI.D.1.d of this document and in the PBRINE TSD.

### **VIII. Where can I get more information about the EPA's WIPP-related activities?**

#### **A. *Supporting Documents for Recertification***

The CARDS discuss DOE's compliance with each of the individual requirements of the WIPP Compliance Criteria. The CARDS also list the EPA TSDs and any other references used by the EPA in rendering the decision on compliance. All TSDs and references are available in the Agency's dockets, via [www.regulations.gov](http://www.regulations.gov) (Docket ID No. EPA-HQ-OAR-2014-0609), with the exception of generally available references and those documents already maintained by the DOE or its contractors in locations accessible to the public. For more detailed information on the technical issues considered in the EPA's recertification decision, see the TSDs.

#### **B. *The WIPP Website & WIPP-NEWS E-mail Listserv***

For more general information and updates on the EPA's WIPP activities, please visit the WIPP internet homepage at <<https://www.epa.gov/radiation/epas-role-waste-isolation-pilot-plant-wipp>>. All pertinent recertification-related documents (including the DOE-submitted recertification materials, letters, Federal Register notices, outreach materials, etc.) are available for review or download in Adobe PDF format. The Agency's WIPP-NEWS e-mail listserv, which automatically sends messages to subscribers with up-to-date WIPP announcements and information, is also available online. Any individuals wishing to subscribe to the listserv can join by visiting <[https://lists.epa.gov/read/all\\_forums/subscribe?name=wipp-news](https://lists.epa.gov/read/all_forums/subscribe?name=wipp-news)> and providing all requested information to register.

### **C. *Dockets***

In accordance with 40 CFR 194.67, the EPA maintains public dockets via [www.regulations.gov](http://www.regulations.gov) (Docket ID No. EPA-HQ-OAR-2014-0609) that contain all the information used to support the Agency's decision on recertification. The Agency maintains the formal hard copy/paper docket in Washington, D.C., as well as informational dockets in three locations in the State of New Mexico (Carlsbad, Albuquerque, and Santa Fe). The docket consists of all relevant, significant information received to date from outside parties and all significant information considered by the EPA in reaching a recertification decision regarding whether the WIPP facility continues to comply with the disposal regulations.

### **IX. What is the EPA's role in future WIPP activities?**

The EPA's regulatory role at the WIPP does not end with this recertification decision. The Agency's future WIPP activities include additional recertifications every five years (the next being scheduled to be submitted by the DOE in March 2019), review of the DOE reports on conditions and activities at the WIPP, assessment of waste characterization and quality assurance

programs at waste generator sites, announced and unannounced inspections of the WIPP and other facilities and, if necessary, modification, revocation or suspension of the certification.

As a result of the February 2014 incidents at the WIPP, the DOE will be making changes to the repository design. The DOE has indicated that it no longer plans to use panel 9 for waste operations due to the worker safety hazards in that location, so an alternative panel will be needed. This decision may also have implications for panel closures in the panels accessed through the panel 9 drifts (i.e., panels 3-6). In addition, the DOE is planning a new ventilation shaft that will allow for increased airflow through the underground operations area. The EPA will be keeping abreast of the DOE's requested changes and will make that information available as it is received.

As described in Section VI of this notice, the EPA's review of the 2014 Compliance Recertification Application identified where the DOE's technical basis for the modeling has limitations with assumptions used or with the basis for some parameter values. The EPA concerns with these limitations were generally addressed by the results of the SEN studies. While this approach of using a series of sensitivity studies to examine identified limitations was sufficient in the context of this compliance recertification application, it was to some extent driven by the known upcoming physical changes in the repository. The EPA would prefer to be able to evaluate a complete revised performance assessment in future compliance recertification application reviews. The EPA recommends that the performance assessment technical basis be evaluated for improvement in these areas: 1) calculations of actinide solubility, 2) modeling the chemical conditions in the repository, and 3) modeling direct brine releases.

Although not required by the Administrative Procedure Act (APA), the WIPP LWA or the WIPP Compliance Criteria, the EPA intends to continue docketing all inspection or audit

reports and annual reports and other significant documents on conditions and activities at the WIPP, as well as formal communications between the two agencies.

The EPA plans to conduct future recertification processes using an administrative process generally similar to that described in today's action.

Dated: July 10, 2017.

Sarah Dunham,

Acting Assistant Administrator, Office of Air and Radiation.

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